

Claims

What is claimed is:

1. A gallium nitride (GaN) epitaxial structure comprising:
 - a) a substrate;
 - b) a sacrificial epitaxial layer deposited on the substrate; and
 - c) one or more structural epitaxial layers deposited on the sacrificial epitaxial layer and including a GaN buffer layer;
wherein the substrate and the one or more structural epitaxial layers are separated by oxidizing the sacrificial epitaxial layer.
2. The structure of claim 1 wherein the sacrificial epitaxial layer has a high aluminum mole fraction.
3. The structure of claim 2 wherein the aluminum mole fraction is greater than or equal to 0.3.
4. The structure of claim 2 wherein the aluminum rich sacrificial epitaxial layer is essentially aluminum gallium nitride.
5. The structure of claim 1 wherein the one or more structural epitaxial layers comprises a nucleation layer deposited on the sacrificial epitaxial layer.
6. The structure of claim 5 wherein the oxidation of the sacrificial epitaxial layer further oxidizes the nucleation layer.
7. The structure of claim 5 wherein the GaN buffer layer is deposited on the nucleation layer.
8. The structure of claim 7 wherein the one or more structural epitaxial layers further comprise:
 - a) a barrier layer deposited on the GaN buffer layer; and
 - b) a cap layer deposited on the barrier layer.

9. The structure of claim 8 wherein the barrier layer comprises essentially aluminum gallium nitride.

10. The structure of claim 8 wherein the cap layer comprises essentially gallium nitride.

11. The structure of claim 8 further comprising:

- a) a source ohmic contact formed on the cap layer;
- b) a drain ohmic contact formed on the cap layer; and
- c) a gate contact electrically connected to the cap layer between

the source contact and the drain contact,

wherein the source, gate, and drain contacts are separate contacts.

12. The structure of claim 8 wherein the one or more structural layers further comprises an insulation layer deposited on the cap layer.

13. The structure of claim 12 further comprising:

- a) a source ohmic contact formed on the cap layer;
- b) a drain ohmic contact formed on the cap layer; and
- c) a gate contact electrically connected to the insulation layer

between the source contact and the drain contact,

wherein the source, gate, and drain contacts are separate contacts.

14. The structure of claim 1 wherein the substrate is selected from the group consisting of sapphire, silicon carbide (SiC), silicon, gallium arsenide (GaAs), gallium nitride (GaN), aluminum nitride (AlN), and zinc oxide (ZnO).

15. A method of growing a gallium nitride (GaN) epitaxial structure and fabricating an electronic device comprising:

- a) depositing a sacrificial epitaxial layer on a substrate;
- b) depositing one or more structural epitaxial layers including a nucleation and GaN buffer layer on the sacrificial epitaxial layer; and

c) oxidizing the sacrificial epitaxial layer to separate the substrate from the one or more structural epitaxial layers.

16. The method of claim 15 further comprising fabricating an electronic device using the structural epitaxial layers.

17. The method of claim 15 wherein the one or more structural epitaxial layers further comprises a nucleation layer, further wherein the depositing the one or more structural epitaxial layers step comprises depositing the nucleation layer on the sacrificial epitaxial layer.

18. The method of claim 17 wherein the oxidizing step further oxidizes the nucleation layer.

19. The method of claim 17 wherein the depositing the one or more structural epitaxial layers step further comprises depositing the GaN buffer layer on the nucleation layer.

20. The method of claim 19 wherein the one or more structural epitaxial layers further comprise a barrier layer and a cap layer, further wherein the depositing the one or more structural epitaxial layers step further comprises:

- a) depositing the barrier layer on the GaN buffer layer; and
- b) depositing the cap layer on the barrier layer.

21. The method of claim 20 further comprising:

- a) forming an ohmic source contact on the cap layer;
 - b) forming an ohmic drain contact on the cap layer; and
 - c) forming a gate contact on the cap layer between the source contact and the drain contact,
- wherein the source, gate, and drain contacts are separate contacts.

22. The method of claim 20 wherein the one or more structural epitaxial layers further comprises an insulation layer, further wherein the depositing the

one or more structural epitaxial layers step further comprises depositing the insulation layer on the GaN cap layer.

23. The method of claim 22 further comprising:
- a) forming a source contact on the cap layer;
 - b) forming a drain contact on the cap layer; and
 - c) forming a gate contact on the insulation layer between the source contact and the drain contact,
- wherein the source, gate, and drain contacts are separate contacts.
24. The method of claim 15 wherein the oxidizing step oxidizes the sacrificial epitaxial layer with steam.
25. The method of claim 15 wherein the oxidizing step oxidizes the sacrificial epitaxial layer with hydrogen peroxide.
26. A method of fabricating an electronic device comprising:
- a) depositing a sacrificial epitaxial layer on a substrate;
 - b) depositing one or more structural epitaxial layers including a nucleation and gallium nitride (GaN) buffer layer on the sacrificial epitaxial layer;
 - c) fabricating an electronic device on the structural epitaxial layers;
- and
- d) oxidizing the sacrificial epitaxial layer to separate the substrate from the electronic device.
27. The method of claim 26 wherein the one or more structural epitaxial layers further comprises a nucleation layer, further wherein the depositing the one or more structural epitaxial layers step comprises depositing the nucleation layer on the sacrificial epitaxial layer.
28. The method of claim 27 wherein the oxidizing step further oxidizes the nucleation layer.

29. The method of claim 27 wherein the depositing the one or more structural epitaxial layers step further comprises depositing the GaN buffer layer on the nucleation layer.

30. The method of claim 29 wherein the one or more structural epitaxial layers further comprises a barrier layer and a cap layer, further wherein the depositing the one or more structural epitaxial layers step further comprises:

- i) depositing the barrier layer on the GaN buffer layer; and
- ii) depositing the cap layer on the barrier layer.

31. The method of claim 30 wherein the fabricating step comprises:

- i) forming an ohmic source contact on the cap layer;
- ii) forming an ohmic drain contact on the cap layer; and
- iii) forming a gate contact on the cap layer between the source

contact and the drain contact,

wherein the source, gate, and drain contacts are separate contacts.

32. The method of claim 30 wherein the one or more structural epitaxial layers further comprises an insulation layer, further wherein the depositing the one or more structural epitaxial layers step further comprises depositing the insulation layer on the GaN cap layer.

33. The method of claim 32 wherein the fabricating step comprises:

- i) forming an ohmic source contact on the cap layer;
- ii) forming an ohmic drain contact on the cap layer; and
- iii) forming a gate contact on the insulation layer between the

source contact and the drain contact,

wherein the source, gate, and drain contacts are separate contacts.

34. The method of claim 26 wherein the oxidizing step oxidizes the sacrificial epitaxial layer with steam.

35. The method of claim 26 wherein the oxidizing step oxidizes the sacrificial epitaxial layer with hydrogen peroxide.